EXPERIMENT #5
AM DETECTOR AND SYSTEM OPERATION

## *INTRODUCTION:*

Once the appropriate carrier signal has been selected and amplified in a radio receiver, one of the final steps remaining is to recover the intelligence. A circuit that does this job is called a *detector* or *demodulator.* For AM signals, a diode can be used as a detector.

## *CIRCUIT ANALYSIS:*

Figure 1 shows a simplified version of the AM detector circuit. Looks kind of like a half-wave rectifier, eh? Well in one sense, it is --because an AM diode detector relies on rectification to recover the intelligence from a carrier wave.

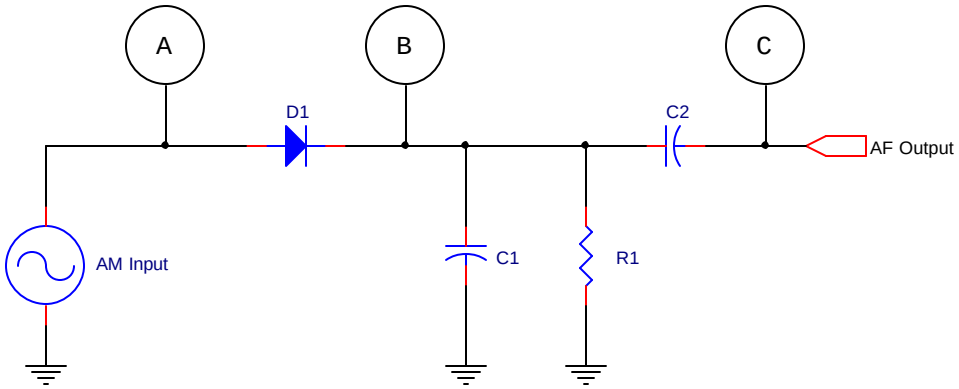



*Figure 1: Simplified AM Detector*

Figure 2a shows a typical modulated carrier wave that might be seen at the input to the detector stage (test point *A*) in a radio receiver. It has the exact same envelope shape as the transmitted wave had at the transmitter.

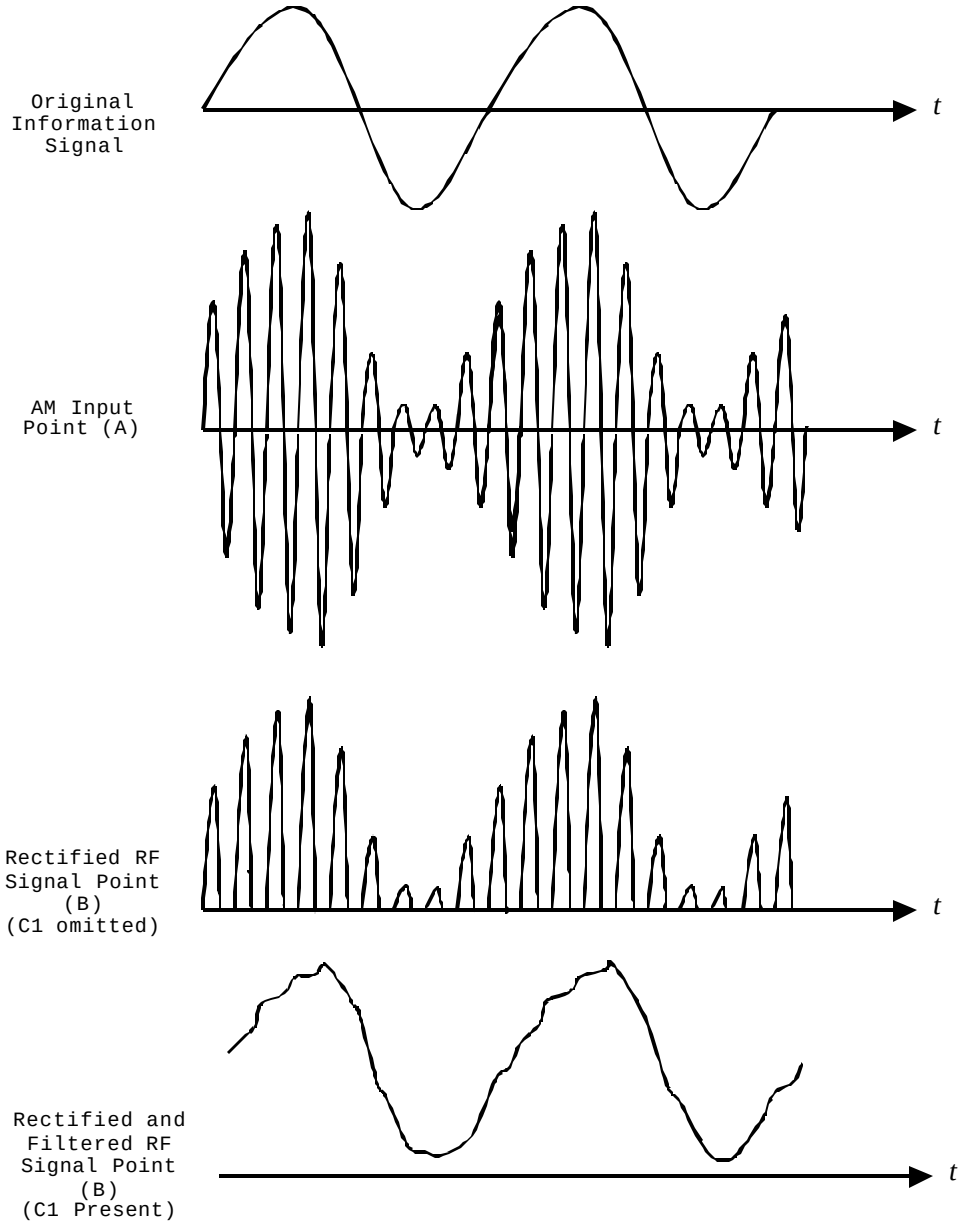



*Figure 2: Detector Waveforms*

If the carrier wave of Figure 2a were fed into a half-wave rectifier circuit with no filtering, the result would look like wave Figure 2b. The detector diode simply chops off the negative portions of the wave!

The output from a half-wave rectifier wouldn't be "smooth" like the envelope without some help. Figure 2c shows what happens when we add a filter capacitor to the circuit. Can you see a difference between the filtering in a detector circuit, versus the filtering in a power supply rectifier circuit? Yes, of course--in a power supply, we want nice, steady DC. That means a *big* filter capacitor. But in an AM detector, we want to see the *envelope* shape...but the envelope is fairly rapidly changing...so that must mean that we use fairly small capacitors in detector circuits. We wouldn't want to filter out the intelligence!

There's only one potential problem with a simple AM detector like the one in Figure 1. What would happen to the capacitor voltage if there were no load resistance, R1, to discharge it periodically? Yes,

right again!  Without a load resistor, the capacitor C1 will just charge up to the highest peak value on the envelope and *stay there*...definitely not desirable.  A practical detector circuit always has a discharge path for the capacitor. Sometimes the load resistor is called a "bleeder" resistor, because it "bleeds" the charge off the capacitor at a rate just fast enough to keep up with the falling portions of
the envelope. R1 functions as the bleeder resistor in the circuit.

Capacitor C2 serves as a *DC block*. There was no DC in the original information signal, and although the diode detector produces a rectified DC component, it is not needed. Figure 3 shows the actual detector circuit you'll use in this experiment. It contains additional filtering to further smooth the recovered envelope shape. This filtering is provided by R2 and C3.

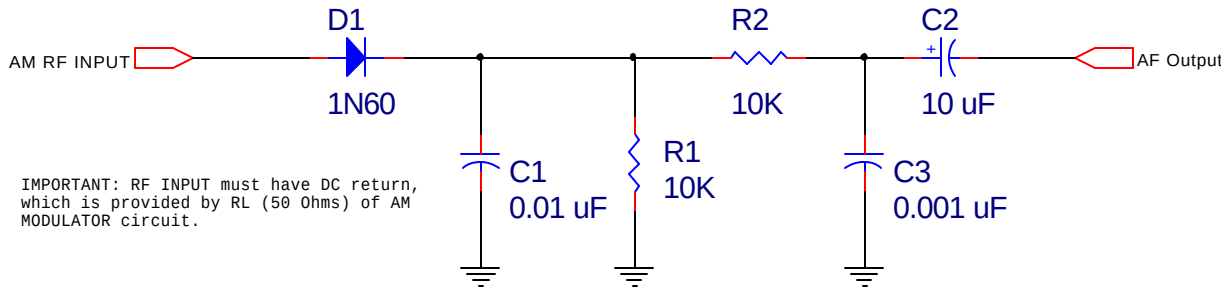



*Figure 3: AM Diode Detector Circuit*

## *LABORATORY PROCEDURE:*

Name _____ Sign-off _____

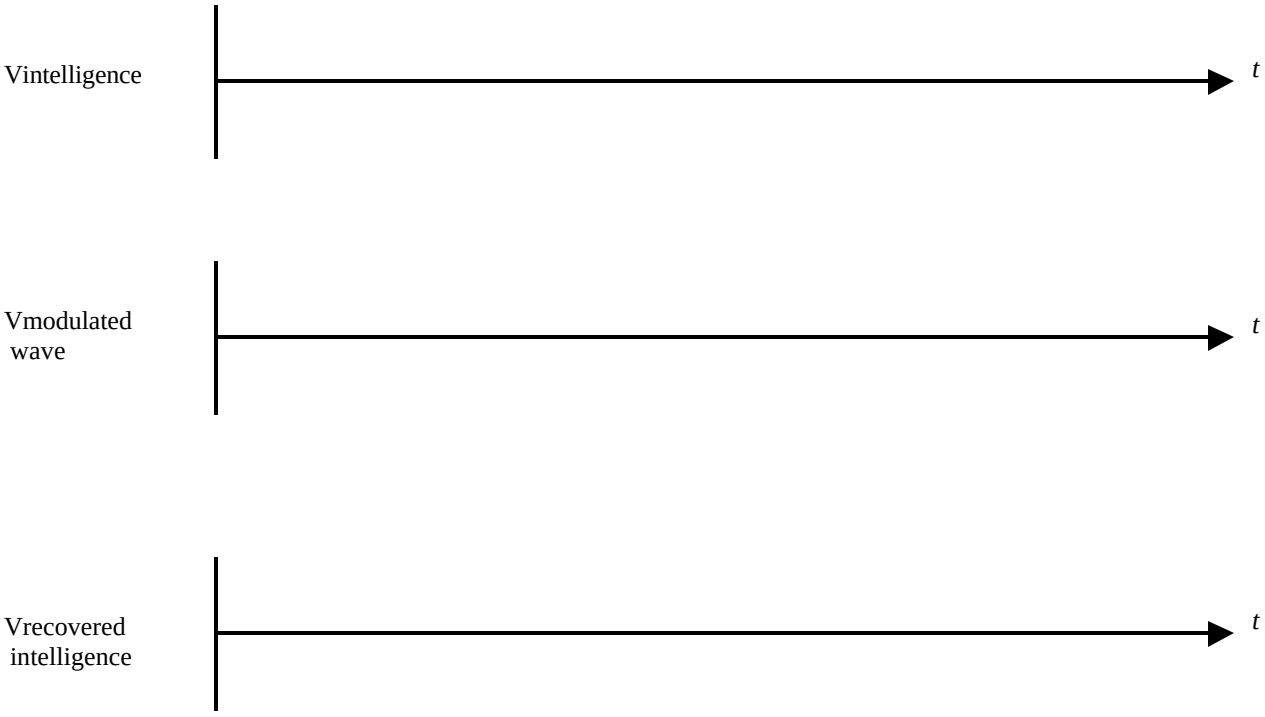
1. Build the circuit of Figure 3. *Note: The 1N60 is a relatively large diode with a clear glass envelope and a black or red cathode stripe.*

2. Setup the AM MODULATOR circuit to deliver a 50% (or more) modulated wave, with 1 KHz intelligence from the benchtop signal generator. Connect the *AM RF OUTPUT* of the modulator to the *AM RF INPUT* of the detector. Don't forget to connect circuit grounds together.

   *TIP: The AM MODULATOR must be producing at least 2 Vpp RF for the detector circuit to work properly.*

3. Record the following signals (be sure to trigger off the intelligence from the signal generator in all cases):

4. Let's see what overmodulation looks like at the detector in the receiver. Adjust the AM modulator for more than 100% modulation, then record the following waveforms:




5. What was the effect of overmodulation on the recovered intelligence?

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6. Did you save the *audio monitor* (Experiment #1)? If so, connect the audio monitor *audio input* to the AF OUTPUT of the AM detector. You should now hear the audio from the signal generator.

## *Optional Exercise: A Complete Untuned AM Receiver*

The circuit below combines the *audio monitor* of experiment 1 with the *AM detector* to form a complete AM broadcast receiver. The receiver is "untuned," meaning that *no* bandpass filtering is attempted on the RF signals prior to detection. You may hear one or many signals with this circuit! Figure 4 shows how to build it.

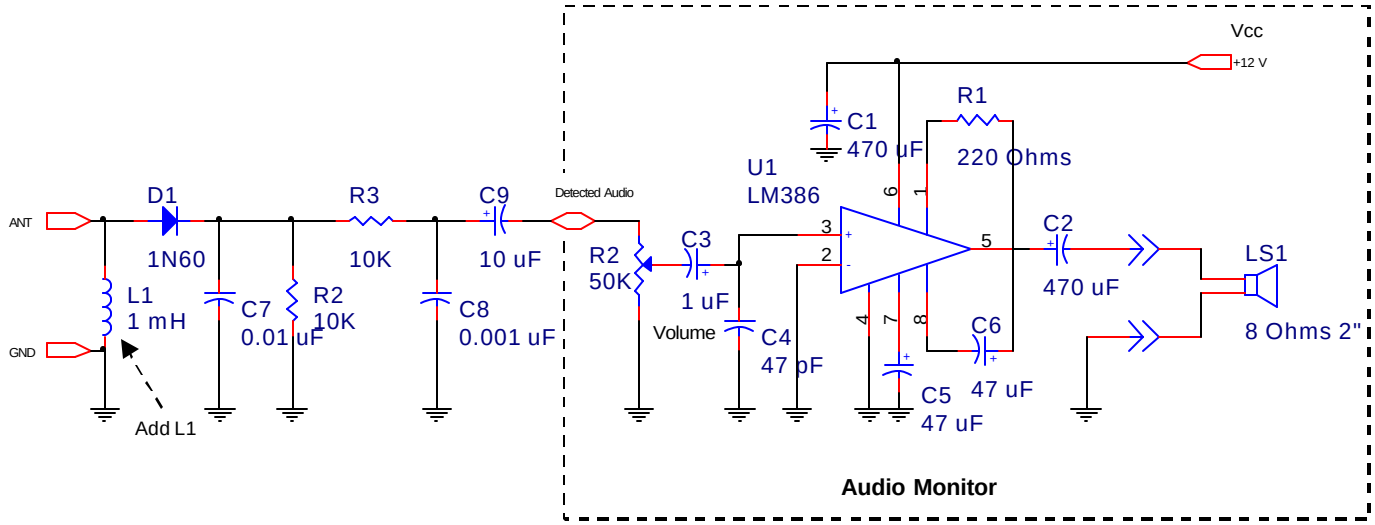


*Figure 4: Untuned AM Receiver*

A long-wire antenna should be connected to the *ANT* terminal. This should consist of at least 20 feet of wire, preferably hung outside of a building (such as in a tree). Keep the antenna away from overhead power lines! The *GND* terminal should be connected to a good earth ground, such as a copper water pipe, or ground rod. The 10 mH inductor from experiment 2 can be used in place of L1 if desired. Its value is not critical.

For portable operation, a 9-Volt transistor battery will run this little receiver for many hours. Good luck and happy listening!

## *QUESTIONS*

1. What is similar between an AM detector and a half-wave power supply circuit?

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2. What would happen if the bleeder resistor in an AM detector circuit failed by opening up?

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3. On a separate sheet of paper, draw a block diagram of the entire system you built. Below, describe how it operates as a whole.

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